Virtual Security Shield (VSS™) White Paper

The security concerns of a large property often include protection of remote perimeters that abut undeveloped land or a body of water. Potential access to the property from these areas poses the biggest challenge to a true perimeter security system and requires a multilayered solution. An effective area-wide system enables early detection of intruders and the ability to distinguish between friend and foe.

To address this need, Duos has integrated a number of technologies into the Virtual Security Shield (VSS™) system. VSS™ is based on proven digital video and sensing technologies (including ground radar and Radio Frequency Identification) that interact with proprietary artificial intelligence algorithms. Data from all security layers is fused into an immersive, intuitive security tool to secure a broad coverage area and its perimeters.

VSS™ includes the following capabilities:

- **Early Detection and Classification** of potential threats
- **Authentication** of vehicles and personnel entering a secure area
- **Tracking** of vehicles and personnel in the secure area
- **Prevention** of unauthorized vehicle use

**VSS™ Structure**

As shown in Figure 1, VSS™ employs multiple components to prevent unauthorized access to a secure area:

- Ground radar
- Visual Verification and Archiving
- Live-360° panorama
- On-demand Pan/Tilt/Zoom cameras
- Radio Frequency Identification (RFID) technology
- Real Time Location (RTL) system
- Vehicle access control
- Friend or foe classification

*Figure 1 – VSS Layers 1 - 3*
1. Ground Radar Layer

Digital ground-based radar forms the core detection layer of the Virtual Security Shield, providing real time situational awareness in all environmental conditions.

Radar can survey very large areas quickly and efficiently and the radar signature can be shaped to monitor a specific area of interest. By filtering clutter, radar provides an accurate surveillance solution with a low false alarm rate. People, vehicles, boats, or low flying aircraft can be tracked and classified to provide a window for measured response. Alerts are configured to provide early warning of suspicious activity or perimeter breaches.

The radar signal is captured and digitized into standard commercial off the shelf (COTS) PC-based hardware. The converted signal is layered into a Plan-Position Indicator display and tracking plots are overlaid onto an aerial image of the entire property. The automated system detects targets that breach the perimeter.

Control software allows operators to set coverage parameters and configure the overall execution flow. VSS™ software algorithms manage multiple dynamic targets and alarms, varying target dynamics as necessary. Control parameters can be adjusted by the operator to optimize surveillance scenarios.

When a potential threat is detected, the system positions Pan/Tilt/Zoom (PTZ) cameras for close-up observation of the approaching object. The combination of intelligent video algorithms and RFID technologies classifies the object as friend or foe, and alerts security personnel if the analysis indicates the presence of an intruder.

2. Visual Verification & Archival Layer

Video security systems may fail to provide sufficient resolution to monitor a large area, limiting the user to a single perspective. The VSS™ visual verification layer provides complete area coverage using an application that creates live-360° panoramic views of a scene harvested from rotating PTZ camera images (see Figure 2).

Figure 2. One-half of a live-360° degree panoramic view generated by VSS™. The secure area is constantly scanned and live video images are stitched together to provide a virtual panoramic view.

High-resolution day/night PTZ cameras supply the quality video images for the VSS™ visual verification layer and also provide the multiple perspectives vital to threat analysis (see Figure 3). PTZs can be controlled automatically by an Artificial Intelligence Module (DAIM), or manually on demand by security personnel. Manual control involves clicking on the live-360° panorama to operate the PTZs closest to the point of interest, which present an optically enhanced image from multiple perspectives.
Video streams are archived for post-event analysis. In order to process this information efficiently, visual information is integrated into the live-360° panoramic view, providing the operator with a real-time comprehensive snapshot for investigation of events. The live panoramic view serves as the starting point for further analysis in the third layer.

3. RFID Layer

This layer combines RFID technology with the live-360° panoramic view of the site, allowing security personnel to identify and track the movement of unauthorized vehicles or personnel (friend or foe). The VSS™ RFID layer is an active RFID solution with Real Time Location (RTL) capabilities. It employs stationary RFID readers, mobile RFID readers, active RFID tags, and comprehensive RFID/RTLS software that provides animated mapping, including real-time tracking of all active tags (see Figure 4).
3.1 Stationary readers. Stationary readers are located at regulation distances around the perimeter of the secure area and at strategic locations within it. Stationary readers use signal triangulation to observe the motion of any tagged object or person in real time.

3.2 RFID tags. All vehicles are registered in the system and equipped with active RFID tags. Authorized personnel are also registered and issued an RFID-enabled badge. This allows real time tracking of assets and personnel as well as association of personnel who are authorized to use specific, tagged assets.

3.3 Mobile readers. Mobile readers are installed in all vehicles that are authorized to access the secure area. Mobile readers verify that only authorized personnel with an RFID-enabled badge can use the vehicles. Mobile readers use a negligible amount of car battery power.

To prevent the illegal use of vehicles, the VSS™ RFID layer employs a vehicle/personnel association technique. An RFID reader interrogates individual access control tags to recognize authorized personnel. The RFID pass/fail signal is synchronized with vehicle immobilizers that prevent unauthorized individuals from activating the vehicles.

3.4 Software and data management. The data transfer model consists of three elements:

   a. Data harvesting
   b. Data utilization
   c. Data storage
Data harvesting

Each active RFID tag is assigned a unique identification number. The tag transmits a radio frequency signal that is read by any RFID reader within range to locate the tag holder.

Data utilization

Harvested data is passed to RFID middleware that processes the signal and translates it into a position on a grid of the property. The result is a live map that displays animated icons showing the location of every vehicle and authorized personnel. The animated positioning map is overlaid on the live-360° panoramic map, displaying real-time positions on the VSS™ operator interface. In cooperation with ground radar, any vehicle not positively identified by RFID signal is considered unauthorized and the system issues an alert.

Data storage

The system records and stores alarm events to enable forensic review of vehicle and personnel movements.

Concept of Operation

In the following scenario, VSS™ identifies a threat and alerts security personnel:

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<th>STEP 1</th>
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<tr>
<td>The Artificial Intelligence Module (DAIM) detects vehicles or people via ground radar. The PTZ automatically pans and zooms in to view the object. The RFID system interrogates RFID readers in the field and determines whether the person or vehicle is authorized. If the vehicle or person lacks an authorized ID, the system declares the object a foe and generates an alarm</td>
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<th>STEP 2</th>
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<th>STEP 3</th>
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<td>Security personnel confer with a supervisor and determine the appropriate response.</td>
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In the following scenario, security personnel use VSS™ to monitor and control vehicle access:

**STEP 1**
RFID readers show authorized vehicle positions and occupants in the scene.

**STEP 2**
If a rider or vehicle is not authenticated by the RFID, the vehicle will not start. If a vehicle is moving and the RFID indicates no rider is authenticated, DAIM will generate an alarm.

**STEP 3**
Security personnel respond to the alarm by analyzing the situation from live-360° panorama and the multi-perspective VSS™ console views.

**STEP 4**
Security personnel control the PTZs to further investigate the scene and the nature of the threat.

**STEP 5**
Security personnel confer with a supervisor and determine the appropriate response.

**Summary**
VSS™ systems offer an effective solution to a challenging security problem. Duos Technologies offers complete VSS™ systems at a turnkey price that is quoted upon completion of a site survey. We are happy to provide more information or a demonstration of our systems and discuss the needs of a particular location.